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CONTRIBUTIONS FROM THE HARVARD MINERALOGICAL MUSEUM.—XI.

A DESCRIPTION OF EPIDOTE CRYSTALS FROM ALASKA.

By Charles Palache.

Presented by John E. Wolff, January 8, 1902. Received February 7, 1902.

The epidote crystals described in this paper were sent to the Harvard Mineralogical Laboratory for crystallographic study by Mr. W. C. Hart of Manitou, Colorado, to whom we wish to express our thanks for the generous supply of material placed at our disposal.

This material is from a new locality for the mineral and is remarkable for the size and unusual habit of the crystals; it therefore seemed well worthy of description.

According to Mr. Hart the epidote is found at Sulzer, Prince of Wales Island, Alaska. It is in the close vicinity of a body of copper ore and is further associated with garnet, albite, magnetite, and quartz. The country rock of the region is limestone, which is cut by numerous igneous dykes, and it seems probable that the deposit is the result of contact metamorphism of the limestone by the dyke rocks, resembling closely in this respect the epidote occurrence with copper ore in the Seven Devils Mts. in Idaho.*

The specimens at hand consist of several loose crystals and a magnificent cluster of large crystals implanted on massive epidote. The only associated mineral is quartz in small clear crystals of later formation than the epidote.

The epidote is very dark green to greenish black in color, but oil-green and translucent in thin crystals or where bruised or cracked. The larger crystals are in the form of nearly square tables, which measure as much as 5.5 cm. each way and 3 cm. in thickness. In the smaller crystals the tabular habit is less pronounced and the mineral sometimes assumes the ordinary prismatic habit parallel to the $\bar{b}$ axis. The crystals are not infrequently doubly terminated. In the large group to which reference was made about twenty of the tabular crystals are found on a surface measuring about 15 by 20 cm., several of the crystals over 3 cm. on an edge, and attached by an edge in such fashion as to present an appearance altogether foreign to epidote. The crystals are frequently twinned according to the ordinary law for epidote, twinning plane the orthopinacoid.

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* Compare Am. J. Science, VIII, 1899, 299.

Measurement of numerous crystals proved the presence of some twenty-six forms as shown in the following list. The smaller crystals were measured on the two-circle goniometer and most of the faces gave excellent reflections. For the large crystals contact measurements were used, and these, with a study of zonal relations made determinations of forms fairly certain. A few forms were thus found that were not observed on the smaller crystals. Two forms new for epidote are marked with an asterisk.

c (001), b (010), a (100), u (210), z (110), o (011), e (101),
i $(\bar{1}02)$, N $(\bar{3}04)$, r $(\bar{1}01)$, l $(\bar{2}01)$, n $(\bar{1}11)$, α $(\bar{2}12)$, F $(\bar{4}54)$,
Z $(\bar{2}32)$, Φ $(\bar{3}53)$, ϕ $(\bar{1}21)$, δ $(\bar{1}41)$, E $(\bar{1}51)$, q $(\bar{2}21)$, O $(\bar{5}44)$,*
j $(\bar{7}55)$,* X $(\bar{3}22)$, y $(\bar{2}11)$, R $(\bar{4}11)$, Ψ $(\bar{4}13)$.

Of these forms *c*, *a*, *b*, *u*, *r*, and *n* are nearly always present and define the habit of most crystals. *z*, *e*, *o*, and *q* are also found on many crystals; the remaining forms are rare and subordinate in development. The forms may be characterized as follows:

c (001) always present, bright and unstriated, often broad.

b (010) always present, always dull and striated parallel to intersection with *n*; generally has narrow faces.

a (100) always present; the largest face on tabular crystals; bright but often striated faintly horizontally.

u (210) always present, generally with large bright faces.

z (110) generally quite subordinate to *u* but frequently present as a narrow face and always pitted and dull.

o (011) bright face, generally small.

e (101), i $(\bar{1}02)$, N $(\bar{3}04)$, l $(\bar{2}01)$ are infrequent forms in orthodome zone, generally narrow, bright and unstriated when they do occur. This zone is remarkably poor in forms and free from striation as compared with most crystals of epidote.

r $(\bar{1}01)$ always present, broad, generally striated lightly and less brilliant than *c* with which it is easily confused on the crystals.

n $(\bar{1}11)$ always present, often large, brilliant, and striated. The only form found in the re-entrant angles rarely found on twin crystals.

α $(\bar{2}12)$ present on one crystal only (figure 7) as a large, fairly bright face.

F $(\bar{4}54)$, Z $(\bar{2}32)$, Φ $(\bar{3}53)$, ϕ $(\bar{1}21)$, δ $(\bar{1}41)$, and E $(\bar{1}51)$ are pyramids of the zone $[\bar{1}11$ to $010]$. Unimportant forms but several of them sometimes present on single crystals as shown in the drawings. F $(\bar{4}54)$, a rare form for epidote, has been reported heretofore only from Persberg, Sweden* by Flink; he determined it by a single bright face in two zones, no angles being given. It was found with a single face on each of two crystals and was measured as follows:

	Measured.		Quality.	Calculated.		
	ϕ	ρ		ϕ	ρ	
$\bar{4}54$	—160° 40′	67° 21′	fair	—160° 43′	67° 18′	(010 as pole)
	128° 01′	29° 33′	fair	128° 18′	29° 27′	(normal position)

Φ and δ were determined solely by contact measurements; Z and ϕ by contact measurements and zonal relations.

q $(\bar{2}21)$ often present, sometimes large, always dull.

O $(\bar{5}44)$, j $(\bar{7}55)$, X $(\bar{3}22)$, y $(\bar{2}11)$, and R $(\bar{4}11)$ are pyramids of the zone $[\bar{1}11$ to $100]$. Of these forms *y* alone is common; *O* and *j* are new to epidote and *X* and *R* are rare.

O was measured on three crystals (two of them twins) with six faces as follows:

	Measured.		Quality.	Calculated (010 as pole).	
$\bar{5}44$	ϕ	ρ		ϕ	ρ
Crystal No. 4,	—42° 04′	38° 30′	poor	42° 07′	39° 33′
" " 5,	42 57	39 11	fair	42 07	39 33
	137 06	38 58	fair	137 53	39 33
" " 6,	—42 13	39 20	good	—42 07	39 33
	—137 37	39 19	good	—137 53	39 33
	136 48	39 18	fair	137 53	39 33
Average $-\phi' = \pm\phi$ or $180° - \phi$	—42° 07′	39° 33′		—42° 37′	39° 06′

The agreement of measured and calculated angles is not very close, but the form seems assured.

j was measured on two twin crystals with three faces as follows:

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* Bihang t. K. Sv. Vet. Akad. H. Stockholm, **12**, No. 2, 1886.

	Measured.		Quality.	Calculated.	
$\bar{7}55$	ϕ	ρ		ϕ	ρ
	37°41′	42° 17′	fair	37° 40′	42° 11′
	142 07	41 44	poor	142 20	42 11
	143 16	42 42	bad	142 07	42 11
Average ϕ or 180° —ϕ =	37° 26′	42° 14′		37° 40′	42° 11′

The agreement between measured and calculated angles is here fairly satisfactory and the form seems assured.

X ($\bar{3}22$) has been reported only once on epidote from Elba by A. Artini * who measured a single bright face agreeing well with its calculated angle.

It was found here on a single crystal with one measurable face, but was noted frequently as a dull face in the zone [$\bar{2}21$ to $\bar{1}01$].

	Measured		Calculated (010 as pole)	
	ϕ	ρ	ϕ	ρ
$\bar{3}22$	142° 00′	66° 08′	141° 47′	66° 20′

y ($\bar{2}11$) and *R* ($\bar{4}11$) were the commonest forms of this series and were well determined by measurement on several crystals.

Ψ ($\bar{4}13$) present only on one crystal (figure 7) as a small face.

Several of the above forms are lacking in the Winkeltabellen of Goldschmidt, and as the various values there given have been calculated for each of them they are given in the following table, which also includes two forms for which certain values were found to be incorrectly stated in the Tabellen:

No	Letter	Symb.	ϕ	ρ	ξ_0	η_0	ξ	η	x'	y'	d'
			° ′	° ′	° ′	° ′	° ′	° ′			
†54	Φ	$\bar{3}53$	. . .	. . .	. . .	. . .	. . .	67 34	. . .	. . .	. . .
‡79	Ψ	$\bar{4}13$	$\bar{6}3$ 34	53 31	$\bar{5}0$ 27	31 02	$\bar{4}6$ 04	20 58	$\bar{1}$.2113	0.6019	1.3525
83	F	$\bar{4}54$	$\bar{1}9$ 17	67 18	$\bar{3}8$ 18	66 06	$\bar{1}7$ 44	60 33	$\bar{0}$.7897	2.2570	2.3914
84	O	$\bar{5}44$	$\bar{3}1$ 29	64 43	$\bar{4}7$ 53	61 01	$\bar{2}8$ 11	50 27	$\bar{1}$.1060	1.8057	2.1176
85	j	$\bar{7}55$	$\bar{3}5$ 39	65 46	$\bar{5}2$ 20	61 01	$\bar{3}2$ 07	.47 49	$\bar{1}$.2955	1.8057	2.2224
86	X	$\bar{3}22$	$\bar{3}8$ 13	66 29	$\bar{5}4$ 53	61 01	$\bar{3}4$ 34	46 05	$\bar{1}$.4220	1.8057	2.2983

The drawings show the extremely variable habit of the crystals.

Figure 1 represents perhaps the commonest type, a tabular twin crystal, the two individuals entirely symmetrical to the twinning plane and so developed as to present no re-entrant angles. Here as in all the twin crystals the reversal of direction of the striations on 010 in the twinned crystal is the easiest means of recognizing the composite nature of the group.

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* Mem. Acad. Lincei. 4, 380, 1887.

† Correction, Winkeltabellen, p. 130, line 32 from above, col. 10.

‡ Correction, Winkeltabellen, p. 131, line 12 from above, whole line.

Figures 2 and 2a are orthographic projections of the same crystal on the orthopinacoid and the clinopinacoid respectively. They represent the largest crystal studied in natural size, and show how irregularly the two twinned crystals are sometimes united — in this case an imperfect penetration having taken place. The upper surface of this crystal is bounded by cleavage planes parallel to *c* where the crystal was broken from its matrix.

The remaining figures (3 to 7) are orthographic projections on the clinopinacoid.

Figure 3 is another tabular crystal in which the larger portion of the crystal is a single individual. Rarely such tabular crystals are untwinned.

Figures 4 and 5 are two very symmetrical twin crystals, both prismatic parallel to the axis $\bar{b}$ and doubly terminated. They show many of the less common forms and the re-entrant angle between two faces of *n* which is not common on these crystals.

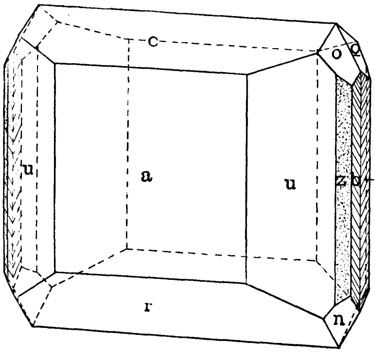
Figure 6 is a type of the untwinned crystal, prismatic parallel to axis $\bar{b}$, the usual epidote habit. It is a left-hand termination. Many of the smaller crystals are of this habit with varying development of the planes of *n* and *u*.

Figure 7 is a small crystal of prismatic habit but quite unlike any other found in its terminal planes.

In conclusion it may be said that this Alaska epidote ranks among the finest occurrences of American crystallized minerals, and is only surpassed in the size, beauty, and complexity of its crystals by the epidote from the Knappenwand in the Tyrol.

MINERALOGICAL LABORATORY, HARVARD UNIVERSITY,
January, 1902.

Palache. — Epidote Crystals.



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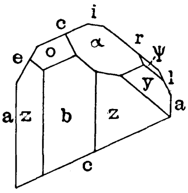

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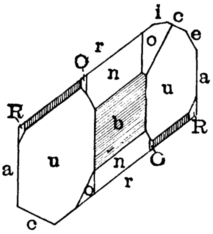

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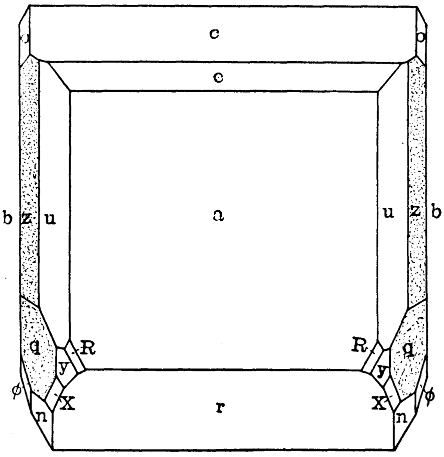

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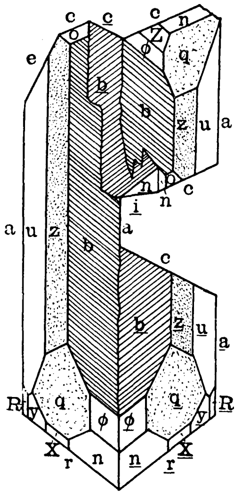

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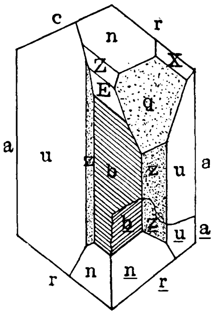

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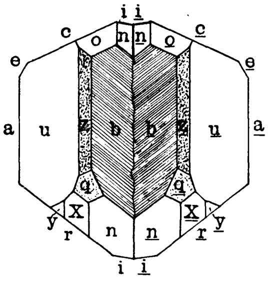

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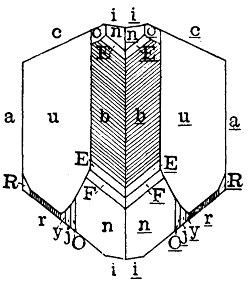

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